JPRS-UMS-88-007
4 APRIL 1988

FOREIGN BROADCAST INFORMATION SERVICE

JPRS Report

Science & Technology

USSR: Materials Science

JPRS-UMS-88-007

4 APRIL 1988

SCIENCE & TECHNOLOGY

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UDC 669.187.526:534.28:539.43.001.4

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18420197 Kiev PROBLEMY SPETSIALNOY ELEKTROMETALLURGII in Russian No 4, Oct-Dec 87 (manuscript received 4 Jan 87) pp 61-65

[Article by Yu. F. Lugovskiy, Institute of Materials Science Problems, UkSSR Academy of Sciences]

[Abstract] In order to determine the dependence of the endurance limit of dispersion-reinforced composite condensate materials for coatings produced by electron-beam vacuum evaporation on the volume fraction of the reinforcing phase, it has been necessary to develop a special methodology of flexural fatigue testing. Since standard specimens with variable cross-section cannot be produced on account of the very small coating thickness, coating specimens are mounted in cantilever fashion in an elastic vibrator beam-clamp of known stiffness. The test procedure involves high-frequency resonance loading, an appreciable acceleration of life tests being feasible with loading at frequencies of 300-20,000 Hz. Testing in the second vibration mode allows use of shorter coating specimens than for testing in the third mode, with the clamp preferably vibrating in a mode close to the first one. The methodology, theoretically validated on the basis of applicable stress and strain analysis, has also been validated experimentally in approximate but reliable determination of $\sigma_{-1} = f(\%V)$ and $\sigma = f(N)$ curves for a series of condensate composites consisting of a Cu matrix with disperse MeX reinforcing particles. References 7: all Russian.

2415/9835

UDC 621.793.7

Structure and Properties of Oxide Coatings Compacted by Phosphate Binders

18420193a Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 87
(manuscript received 27 Oct 87[?]) pp 26-30

[Article by A. L. Borisova and A. A. Tkachenko, Institute of Materials Science Problems, UkSSR Academy of Sciences]

[Abstract] An experimental study of 0.20-0.50 mm thick Al_2O_3, $Al_2O_3 \cdot MgO$, Cr_2O_3, ZrO_2 and TiO_2 oxide coatings produced by the plasma-arc method from powders of 20-80 μm grain size fractions and impregnated with $AlPO_4$ binder or aqueous 85% H_3PO_4 solution was made for structural examination and for comparative evaluation of their properties. The coatings were impregnated at room temperature, some in air and some under vacuum, and then heat treated in air at a temperature of 500°C, which is below the polymorphous transformation point for $AlPO_4$. The data indicate that the impregnation level is a parabolic function of time, the impregnation rate being higher for larger powder grains and for thicker coatings, and also that heat treatment stimulates chemical interaction of oxide and binder resulting in formation of new compounds. Microstructural examination of the coatings in their initial state, after impregnation, and after heat treatment was done under a "Reichert" optical microscope operating in the mode of phase-interference contrast and with a "Superprob" microanalyzer. The following were also measured at each stage: the porosity of coatings, the strength of their adhesion to U8 tool steel, their resistance to abrasive wear according to Brinnel-Havort, their gas permeability, and friction against rayon yarn in an M-27 machine. The results reveal an appreciable overall improvement of coating characteristics after impregnation and heat treatment, vacuum impregnation with $AlPO_4$ being most effective in reducing the porosity but otherwise less effective than vacuum impregnation with H_3PO_4 and air impregnation with H_3PO_4 being least effective. References 4: all Russian.

2415/9835

UDC 620.181.620.17:669.018.29

Structure and Properties of 40Ni2Mo Powder Steel After Isothermal Hardening

18420193b Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 87
(manuscript received 20 Mar 87) pp 30-34

[Article by Yu. G. Gurevich, A. G. Ivashko, V. I. Rakhmanov and I. F. Panyshin, Kurgan Machine Building Institute]

[Abstract] An experimental study of 40Ni2Mo powder steel (0.39-0.41% C, 1.9-2.1% Ni, 0.2-0.3% Mo, density 7.78 g/cm^3) was made for the purpose of

determining the effect of isothermal hardening on its structure and mechanical properties. Compacts of this steel were produced from powders of the component metals and graphite, whereupon 50 mm long bars with 1x10 mm^2 cross-section were formed by hot forging. These specimens had a sorbitic structure with 20% martensite content. Isothermal transformation diagrams were plotted on the basis of magnetic phase analysis, specimens having been austenitized at a temperature of 1183 K for 5 min and then cooled to, and held for 12 min, at various temperatures from 911 K to 523 K in a tin melt. An increasing amount of ferrite, up to 12%, was found to form as the holding temperature was lowered from 911 K to 813 K and sorbite + bainite to form at 813 K. Unstable supercooled austenite was found to transform into upper bainite at 773 K, into bainite almost immediately at 753 K, and into martensite more slowly at 523 K. For measurement of mechanical properties, specimens for tension and impact tests were austenitized at 1183 K for 30 min in a $NaCl-BaCl_2$ salt bath. One batch was then cooled in oil and subsequently tempered in 50% $NaNO_3$ + 50% KNO_3 salt melt to various Vickers hardness numbers, the 573-673 K temperature range and holding for 2 h before final cooling in water being most effective, while the other batch was isothermally hardened to the same Vickers numbers in an identical salt melt at temperatures of 611-653 K. The results indicate that isothermal hardening of this steel favorable to formation of homogeneous bainite improves most of its mechanical properties and also decreases its proneness to brittle fracture. References 9: all Russian.

2415/9835

UDC 621.762.5:621.78.014.5

Changes in Porosity and Defectiveness of Powder Chromium Structure During Electrical-Resistance Sintering

18420193c Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 87 (manuscript received 16 Sep 86) pp 35-38

[Article by L. O. Andrushchik, O. N. Balakshina, S. P. Oshkaderov, Ye. P. Seberyanina and V. A. Shvitay, Metal Physics Institute, UkSSR Academy of Sciences]

[Abstract] An experimental study was made to confirm the feasibility of sintering chromium powder by electrical-resistance heating. Bar specimens 95 mm long with 3 x 10 mm^2 cross-section were produced from Cr-1M powder (0.1% O_2) of grain size fractions below 50 μm at a pressure of 600 MPA. The specimens were heated to 1573 K at an average rate of 1000°C/min by the passage of alternating (50 Hz) electric current with holding at that temperature for periods of 0-10 min in an atmosphere of extra-pure hydrogen. The compaction kinetics and the defectiveness trends were determined with the aid of DRON-3M x-ray diffractometer. Overall porosity, pore concentration, pore diameter and form factor, distance between pores, also microstresses, total number of dislocations, and distance between dislocation mosaics were measured as functions of the holding time. The results indicate that minimum pore concentration but maximum overall porosity with maximum pore

diameter, minimum microstress levels, and minimum total number of dislocations with maximum distance between mosaics are reached after 1 min of isothermal holding at 1573 K, 1-5 min representing the optimum range allowing for a tradeoff between opposing trends. References 7: all Russian.

2415/9835

UDC 621.762:669.14.018.252

Structure and Properties of Tungstenless High-Speed Tool Powder Steels Mo6V1-MP and R-OMo2V3-MP

18420193d Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 87 (manuscript received 16 Feb 87) pp 42-46

[Article by A. N. Popandupulo and M. V. Isakova, Leningrad Polytechnical Institute]

[Abstract] An experimental study of the two most economical high-speed tool powder steels, tungstenless Mo6V1-MP and R-OMo2V3-MP, was made for a determination of their structure and phase composition as well as mechanical properties after austenitization, hardening, and tempering. Specimens of both steels were austenitized in 95% $BaCl_2$ + 5% MgF_2 salt bath at temperatures of 1160-1260°C, cooled to and held for 3 min at 850°C, then cooled in 50% $CaCl_2$ + 30% $BaCl_2$ + 20% NaCl salt bath to 550°C and in air to room temperature. They were tempered in identical baths three times at temperatures of 520-580°C for 1 h each time and, for determination of red hardness, at 600°C, 625°C, 650°C for 4 h at each temperature, also in a laboratory muffle furnace at temperatures of 200-600°C for 1 h at each. Phase analysis and microstructural examination in a DRON-3 x-ray diffractometer and chemical analysis in a modern "Camebax-Micro" x-ray microanalyzer with an energy-dispersion spectrometer and a minicomputer have revealed that this treatment produces a fine-grain structure with a minimal amount of excess carbides, the solubility of carbides being high, and a slightly higher Mo and V content in the solid solution. Tempering at 520-540"C was found to result in high secondary hardness with retention of normal red hardness. References 8: all Russian.

2415/9835

UDC 620.172.251+669.28

Effect of Alloying With Rhenium on Deformation and Fracture Characteristics of Molybdenum Alloy

18420200 Kiev PROBLEMY PROCHNOSTI in Russian No 12, Dec 87
(manuscript received 25 Dec 86) pp 47-49

[Article by I. S. Tsvilyuk, N. I. Kazakova, L. N. Demina and D. S. Avramenko, Strength Problems Institute, UkSSR Academy of Sciences, Kiev, and Central Scientific Research Institute of Ferrous Metallurgy, Moscow]

[Abstract] A comparative strength and plasticity study of vacuum smelted TsMo10 molybdenum alloy, plain and with small rhenium content, was performed for the purpose of determining the "rhenium" effect. Cylindrical ingots 125 mm in diameter, of both alloys were produced in an electric-arc vacuum furnace, forged and rolled into 1 mm thick strips which were annealed for stress relief. Mechanical tests were performed at temperatures covering the 293-2073 K range for tensile strength and percentage elongation, also for the creep limit. The results indicate that small addition of rhenium improves both strength and plasticity of the alloy at all given temperatures, also raising the creep limit especially at 1773-1973 K. The difference tends to diminish with time, however. References 2: both Russian.

2415/9835

UDC 621.791.72/.75:669-419.4:(669.141.24+669.295)

Optimum Conditions for Butt Welding Ti-Steel Bimetal Plates

18420195a Kiev AVTOMATICHESKAYA SVARKA in Russian No 11, Nov 87
(manuscript received 10 Jun 86, in final version 25 Dec 86) pp 6-8

[Article by A. A. Uglov, doctor of technical sciences, and S. V. Selishchev, candidate of physico-mathematical sciences, Metallurgy Institute imeni A. A. Baykov, USSR Academy of Sciences; V. S. Sedykh, doctor of technical sciences, Yu. P. Trykov, doctor of technical sciences, V. I. Lysak, candidate of technical sciences, and A. Yu. Trykov, engineer, Volgograd Polytechnical Institute]

[Abstract] The optimum conditions for electron-beam or argon-arc butt welding of bimetal plates consisting of a VT1-0 titanium layer and a 08Cr18Ni10Ti steel layer are estimated on the basis of theoretical analysis and experimental data. A joint strength diagram has been constructed over the welding temperature-time plane on the basis of hardness measurements and microstructural examination indicating the range of formation of Fe(Ni,Ti) intermetallic compounds as intermediate phase along the Ti-steel interface. The minimum allowable distance from the root of the seam in each layer to the Ti-steel interface is determined on the basis of the equation of heat diffusion, the solution to which yields the temperature at the boundary between the two materials with different melting points as a function of time over the heating period and subsequent cooling period. The results indicate that the joint strength decreases with increasing length of welding time and especially so when the welding temperature is higher than 600°C. The minimum allowable underweld thickness between the two seams is then calculated as a function of the post-welding cooling rate, calculations yielding much higher values than measurements but the same kind of inverse relation and indicating that the only way to minimize that underweld is by increasing the cooling rate. References 5: 4 Russian, 1 Western.

2415/9835

UDC 621.791.72.03:537.533

Control of Seam Geometry During Electron-Beam Welding by Double Refraction of Scanning Beam

18420195b Kiev AVTOMATICHESKAYA SVARKA in Russian No 11, Nov 87
(manuscript received 26 Jun 86, in final version 19 Nov 86) pp 24-26, 30

[Article by K. A. Sukach, engineer, S. N. Kovbasenko, candidate of technical sciences, and Yu. G. Kutsan, candidate of technical sciences, Electric Welding Institute imeni Ye. O. Paton, UkSSR Academy of Sciences]

[Abstract] The possibility of controlling the seam geometry during single-pass electron-beam welding in the scanning mode by means of double refraction

is evaluated on the basis of an experimental study. Double refraction and a resulting convergent scan are achieved with two pairs of deflection plates, one behind the other, along the electron-optical axis of the electron gun. Such a device was experimentally tested in welding together 60 mm thick plates of 12Cr2Ni4MoCu alloy steel in a U-788 welding machine using a 400 mA electron beam generated by a 60 kV electron gun and focus control. Structural examination of macrosections through seams as well as measurements of the seam width as a function of the scan radius at a constant scan rate of 6 m/h and as a function of the scan rate within a constant scan radius of 1 mm, these measurements having been made after welding with single refraction and with double refraction of the electron beam, indicate that double refraction ensures a higher stability of the electron beam position with maximum power density in the plane of scan convergence and thus yields a seam with parallel walls over a wide range of electron-beam parameters. It also ensures a weaker dependence of hot-spot characteristics on both beam current and focusing current. References 5: 4 Russian, 1 Western.

2415/9835

UDC 621.791.75:62-418.1:669.15'26-194

Buildup of Coils of High-Chromium Strip Steels by Means of Arc Welding

18420195c Kiev AVTOMATICHESKAYA SVARKA in Russian No 11, Nov 87
(manuscript received 3 Jun 86, in final version 7 Jul 86) pp 41-45

[Article by K. A. Yushchenko, doctor of technical sciences, Yu. G. Vysotskiy, engineer, A. A. Nakonechnyy, engineer, M. V. Meshkov, engineer, R. I. Morozova, engineer, and V. G. Sapyan, engineer, Electric Welding Institute imeni Ye. O. Paton, UkSSR Academy of Sciences; A. R. Fisher, candidate of technical sciences, and A. V. Lyuft, engineer, Chelyabinsk Metallurgical Combine]

[Abstract] An arc-welding technology for high-chromium strip steels has been developed which yields joints with adequately high plasticity for buildup of coils in cold-rolling mills. It is based on minimizing the heat supply and producing a seam with a high ratio of Ni-equivalent to Cr-equivalent and without stress risers. Welding can be done with a floating electrode in an Ar + 3% O_2 atmosphere with or without filler, with a plasma arc and filler wire, and with a thin floating electrode in a He + (Ar,O_2) atmosphere with or without filler. Each method has been optimized with respect to heat supply for 12Cr17, 08Cr18Ti, 05Cr18ZrMoV, 15Cr25Ti steels with or without any of the three Sv-06Cr19Ni19Ti, Sv-10Cr16Ni25N_2Mo6, Sv-CrNi78Ti wires so as to also ensure adequately high impact and flexural fatigue strength in the heat-affected zone as well as in the seam. References 8: all Russian.

2415/9835

UDC 621.791.72:621.373.826:621.3.085.343

Characteristics of Laser Beam Focusing With Single Spherical Mirrors During Laser Treatment

18420195d Kiev AVTOMATICHESKAYA SVARKA in Russian No 11, Nov 87 (manuscript received 14 Apr 86) pp 55-57

[Article by A. G. Borkin, engineer, S. V. Drobyazko, candidate of physico-mathematical sciences, G. A. Kosheleva, engineer, Yu. V. Pavlovich, engineer, and Yu. M. Senatorov, candidate of chemical sciences, Atomic Energy Institute imeni I. V. Kurchatov; V. A. Fromm, candidate of technical sciences, Scientific Research Center for Laser Technology, USSR Academy of Sciences]

[Abstract] Focusing of a laser beam with a single spherical mirror is analyzed, such a mirror being combined with a rotatable annular plane mirror in a coaxial configuration. Its focal length must be sufficiently large to ensure adequately high power density and to avoid shielding. When the distance from mirror to laser cavity is too large, then the laser beam may degenerate into a nonannular one and its focusing without loss may become unattainable. Tilting the spherical mirror will make this possible, even when the laser beam is not annular, if astigmatism as well as spherical aberration are minimized. Such a focusing mirror made of metal is theoretically shown to be much more effective than a focusing lens made of KCl crystal; this has been confirmed experimentally in a CO_2-laser facility for perforation of tubular separator meshes. References 4: all Russian.

2415/9835

UDC 621.791.053:669.15-194.2:620.193

Corrosion of Welding Seams in Joints of 09Mn2 Hull Steels and Possibility of Rewelding Under Water

18420195e Kiev AVTOMATICHESKAYA SVARKA in Russian No 11, Nov 87 (manuscript received 9 Apr 86, in final version 2 Jul 86) pp 58-60

[Article by A. I. Gusachenko, engineer, I. M. Savich, candidate of technical sciences, and Ye. P. Los, engineer, Electric Welding Institute imeni Ye. O. Paton, UkSSR Academy of Sciences]

[Abstract] A corrosion study of 09Mn2 hull steel with welded joints was made, the purpose being to develop a method of rewelding ship hulls under water. Plates of this steel were welded together along edges with 70° chamfer, whereupon grooves were cut on both sides of the seam simulating corrosion within the heat-affected zone. One batch of seams, produced by welding with UONI-13/55 electrodes in air, had the grooves rewelded under water with identical electrodes on one side and with standard PPS-AN1 powder wire

on the other. A second batch of seams, produced by welding in air with Sv-08Mn2Si wire, had the grooves rewelded in air with AN-Cr7 electrodes on one side and under water with experimental ferritic powder wire on the other. Corrosion tests after rewelding were performed in a bath simulating sea water (26.52 g/l NaCl, 2.45 g/l $MgCl_2$, 3.30 g/l $MgSO_4$, 1.14 g/l CaCl, 0.73 g/l KCl, 0.20 g/l $NaHCO_3$, 0.08 g/l NaB_2) at a temperature of 32-35°C for 1000 h, with the water flowing at a velocity of 10 m/s. The results of these tests, as well as of microstructural examination and hardness measurements, indicate that the standard powder wire is suitable for underwater rewelding of corroded seams, but incorrect operation may result in porosity and reduced corrosion resistance. The experimental powder wire is preferable, especially when alloyed with Cu and Ni. References 3: all Russian.

2415/9835

UDC 621.793.7

Structural Characteristics of Fe-Ni-B Alloy Coatings Deposited by Plasma Arc

18420192 Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 87 (manuscript received 29 Apr 86) pp 22-25

[Article by Yu. S. Borisov, V. Ye. Oliker, V. N. Korzhik, Yu. A. Kunitskiy, A. D. Krasyuk, and S. L. Revo, Electric Welding Institute and Institute of Materials Science Problems, UkSSR Academy of Sciences]

[Abstract] Coatings of $Fe_{40}Ni_{40}B_{20}$ powder alloy, 40-100 μm grain size fraction, were deposited on various metals by the plasma-arc method in a UPU-3 apparatus including a GN-5R plasmatron. Structural examination of such coatings was performed under an MIM-9 optical microscope, in a DRON-2.0 x-ray diffractometer with FeK_α-radiation source, and under an EMV-100AK electron microscope with a "Superprob" JCXA-733 microanalyzer. There was also chemical analysis of the surface by mass-spectrometry of secondary ions during continuous bombardment by a beam of 8 keV Ar^+ ions with a current density of 0.4 $\mu A/cm^2$. The coatings were found to be amorphous with fine-disperse inclusions, 0.5-1 μm size fraction, constituting the eutectic powder alloy of crystalline $(Fe,Ni)_3B$ and $Fe_xNi_{23-x}B_6$ phases with a structure different than that of the original powder. References 9: 4 Russian, 5 Western (1 in Russian translation).

2415/9835

UDC 620.193.01

Kinetics of Dissolution of Cu-Ni Alloys. Anodic Dissolution of Cu + 30% Ni Alloy Under Steady-State Conditions

18420194a Moscow ZASHCHITA METALLOV in Russian Vol 23, No 6, Nov-Dec 87 (manuscript received 23 Feb 87) pp 922-929

[Article by Ye. I. Zolotarev, A. P. Pchelnikov, Ya. B. Skuratnik, M. A. Dembrovskiy (deceased), N. I. Khokhlov and V. V. Dosev, Physical Chemistry Scientific Research Institute imeni L. Ya. Karpov]

[Abstract] Galvanostatic anodic dissolution of the cast 70% Cu + 30% Ni alloy in 1 N H_2SO_4 was measured by a radiometric method, using the ^{58}Co isotope as alien tracer, for the purpose of determining the kinetics of this process and the suitability of this method. The alloy was made of 99.99% pure Cu and 99.93% pure Ni. Test specimens were produced by hot rolling an ingot at 900-950°C for 1 h to 3-4 mm thickness, then annealing in an atmosphere of dissociated NH_3 at 700°C for 1 h, then cold rolling to 0.5 mm thickness, and annealing again in the same atmosphere at 700°C for 1 h. They were subsequently placed inside a nuclear reactor for production of radionuclides ^{64}Cu and ^{65}Ni, also ^{58}Co requiring lengthy neutron bombardment for the $^{58}Ni(n,p)^{58}Co$ reaction. Excessive ^{64}Cu activity and ^{65}Ni decay were prevented by bombardment with thermal neutrons in two stages: with a neutron flux of $8 \cdot 10^{13}$ $cm^{-2}s^{-1}$ intensity first for 200 h and, after a 120-168 h "cooling" period, again for 1 h. The dissolution process and corrosion were tracked by γ-spectrometry with a NaI(Tl) scintillation detector and a Ge(Li) semiconductor detector. The polarization curves with a Tafle slope and buildup of radioactivity at a constant rate indicate dissolution of the alloy governed essentially by behavior of its Cu component, while Ni is known to dissolve selectively under nonsteady conditions. References 30: 22 Russian, 8 Western.

2415/9835

UDC 620.193.01

Changing Electrochemical Properties and Corrosion Characteristics of $Cr_{23}C_6$ Carbide by Alloying With Iron

18420194b Moscow ZASHCHITA METALLOV in Russian Vol 23, No 6, Nov-Dec 87 (manuscript received 16 Jun 86, after revision 16 Feb 87) pp 930-935

[Article by V. M. Knyazheva, S. G. Babich, T. N. Stolyanovskaya and T. G. Tsymlyanskaya, Physical Chemistry Scientific Research Institute imeni L. Ya. Karpov]

[Abstract] An experimental study of alloying the $Cr_{23}C_6$ carbide with iron into compact complex $(Cr_xFe_y)_{23}C_6$ carbides was performed for a determination of the effect on electrochemical properties and corrosion resistance in 0.5 M H_2SO_4. Considering that only up to 25 wt.% of Cr can be replaced by Fe, three such carbides were tested: $(Cr_{0.76}Fe_{0.25})_{23}C_6$, $(Cr_{0.69}Fe_{0.31})_{23}C_6$, $(Cr_{0.67}Fe_{0.33})_{23}C_6$. Measurements were made at a temperature of 20°C, by combining the potentiostatic method with the highly sensitive methods of γ-spectroscopy and atomic absorption for chemical analysis of the dissolution products. The data reveal that alloying with Fe accelerates the dissolution rate of the metal sublattice within the activation range of potentials, and especially at the critical passivation potential, the rate of carbide dissolution remaining far below that of metallic-Cr dissolution. Within the transition and partial passivation ranges the dissolution rate of Cr-Fe carbides is much higher than that of plain $Cr_{23}C_6$ carbide, but still quite low even when the Fe content is high. It therefore appears that Cr-Fe carbides can serve as excess phases or protective coatings for ensuring adequate corrosion resistance of Cr-Ni steels, the selectivity of Cr and Fe dissolution depending on the potential. References 11: all Russian.

2415/9835

UDC 620.193.46

Corrosion Resistance of Aluminum Alloys for Motor-Transport of Mineral Fertilizers

18420194c Moscow ZASHCHITA METALLOV in Russian Vol 23, No 6, Nov-Dec 87 (manuscript received 8 Oct 86) pp 959-962

[Article by V. S. Sinyavskiy, V. D. Valkov and Ye. D. Zakharov, All-Union Light Alloys Institute]

[Abstract] An experimental study of three Al-Mg alloys with respectively 2%, 4% and 5% Mg was performed for a determination of their corrosion resistance in aqueous solutions of mineral fertilizers and, accordingly, their suitability as replacement of St08 rimmed carbon steel in agricultural transportation equipment. Some of the 1-2 mm thick strip specimens were

cold worked to 80% deformation, then heat treated by partial annealing and subsequent tempering. All specimens were tested for pitting and general corrosion in 3% solutions of $(NH_4)_2SO_4$, CaF_2, NH_4NO_3, carbamide, superphosphate, and "nitroammophoska" for 270 days in an environmental chamber and for 90 days fully immersed. The data, converted to mm/yr, indicate that all three alloys have a much higher corrosion resistance than carbon steel, the Al + 2% Mg alloy after low-temperature thermomechanical treatment having the highest, but not so much higher in "nitroammophoska". This fertilizer has simultaneous activation and passivation effects, which metallographic examination reveals to cause all three Al-Mg alloys to retain some proneness to parting. Figures 3; references 3: 2 Russian, 1 Western (in Russian translation).

2415/9835

UDC 620.193:539.219

Dissolution of Amorphous Ti-Zr-Si Alloy During Anodic Oxidation With Buildup of Barrier Films

18420194d Moscow ZASHCHITA METALLOV in Russian Vol 23, No 6, Nov-Dec 87 (manuscript received 19 Mar 86, after revision 30 Nov 86) pp 963-967

[Article by N. I. Isayev, V. B. Yakovlev, A. A. Iovdalskiy and T. P. Gorshkov, All-Union Interindustrial Scientific Research Institute for the Protection of Metals from Corrosion]

[Abstract] An experimental study of the amorphous ~7% Ti + 48% Zr + 5% Si alloy was made for the purpose of determining the kinetics of its dissolution in aqueous 0.01-1.0 wt.% H_3PO_4 and 0.1-10 wt.% H_2SO_4 solutions during anodic oxidation at current desnities up to 10 A/m^2 in the latter. Ribbon specimens 25-30 μm thick and 2 mm wide were produced from the liquid phase by condensation on a fast rotating copper disk in an inert atmosphere at a temperature of 20°C. They were then bombarded with a flux of thermal neutrons of $3 \cdot 10^{13}$ n/(cm$^2 \cdot$c) intensity over a period of 70 h inside a nuclear reactor, with the temperature not allowed to exceed 200°C, which produced principal radionuclides ^{92}Zr, $^{47}Sc(Ti)$ as well as impurity radionuclides ^{182}Ta, ^{64}Cu, ^{51}Cr for chemical analysis of the dissolution products by γ-spectrometry with an "IN-96B" instrument using a high-resolution Ge(Li) semiconductor detector. Galvanostatic oxidation and potentiostatic dissolution were measured in a special electrochemical cell. The results indicate a buildup of barrier films during oxidation and that dissolution of the amorphous Ti-Zr-Si alloy is governed by essentially the same laws as dissolution of the crystalline one, potentiostatic dissolution following the slope of current drop and requiring a larger part of the durrent than galvanostatic oxidation. The dissolution process is evidently tied to the oxidation mechanism and accordingly characterized by a dependence not only on the current density but on the electrolyte composition and concentration as well. The authors thank E. K. Osipov and Ye. A. Trofimova for supplying the amorphous alloy. References 12: 6 Russian, 6 Western (1 in Russian translation).

2415/9835

UDC 620.197.3

Special-Purpose Synthesis of Corrosion Inhibitors on Basis of Sugar Cane Processing Byproducts

18420194e Moscow ZASHCHITA METALLOV in Russian Vol 23, No 6, Nov-Dec 87 (manuscript received 23 Jun 86) pp 968-979

[Article by V. M. Ledovskikh, Kiev Polytechnical Institute]

[Abstract] While sugar cane is Cuba's major industry and discovery of oil deposits can lead to development of another major industry, for metals Cuba must still depend on imports. There is therefore a need to conserve metals used in oil drilling and processing equipment by protecting them against corrosion, and the byproducts of sugar cane processing promise to provide an economical base for protective chemicals. Three such byproducts are under consideration: molasses, furfurol, and wax, including its fractions. An evaluation of their chemistry and electrochemistry has already established their high value as raw materials, some organic derivatives being effective surfactant inhibitors of metal corrosion in acidic media (etchants, detergents) or in aggressive binary media (hydrocarbons plus H_2S or NH_4Cl) and some letallic (Li,Na,Ca) derivatives of wax being effective plastic lubricants. Their performance has been found to be comparable with that of currently used commercial foreign grades so that another category of imports may be eliminated. The author thanks his friends and colleagues at both Havana and Kiev Polytechnical Institutes: G. G. Shimbor, H. A. Dominguez, H. D. Gonzalez, Yu. P. Shapovalov, N. P. Polyanskaya, D. M. Castro, B. Zumalacarregui de Cardenas, and others who have contributed to development of Cuban-made corrosion inhibitors. References 45: 17 Russian, 23 Cuban, 5 Western (3 in Russian translation).

2415/9835

UDC 539.4

Deformation and Strength of Boroplastic-Reinforced Rods at 293 K and 77 K Temperatures

18420199 Kiev PROBLEMY PROCHNOSTI in Russian No 12, Dec 87 (manuscript received 25 Dec 86) pp 38-42

[Article by N. K. Kucher and M. P. Zemtsov, Strength Problems Institute, UkSSR Academy of Sciences, Kiev]

[Abstract] A theoretical stress and strain analysis of a boroplastic-reinforced epoxy rod inside a circular cylindrical sheath of D16T aluminum alloy, based on the equations of balance according to the theory of elasticity and ignoring thermal stresses, yields a prediction of its behavior and strength characteristics at the two contemplated service temperatures of 293 K and 77 K. The results, supplemented with experimental data, reveal the mechanism of force transmission from rod to sheath. They should be helpful in designing multipurpose structural and machine elements with this composite material most economically for optimum performance and maximum reliability. References 11: 8 Russian, 3 Western (in Russian translation).

2415/9835

UDC 620.1:539.434

Effect of Protective Coatings on Life of Heat-Resistant Nickel Steel Under Cyclic Heat Load

18420198 Kiev PROBLEMY PROCHNOSTI in Russian No 12, Dec 87 (manuscript received 10 Dec 86) pp 3-7

[Article by G. N. Tretyachenko, G. R. Semanov, K. Yu. Yakovchuk, R. I. Kuriat, I. S. Malashenko, A. A. Rabinovich and N. P. Vashchilo, Strength Problems Institute and Electric Welding Institute imeni Ye. O. Paton, UkSSR Academy of Sciences, Kiev]

[Abstract] An experimental study of fireproof coatings on heat-resistant high-chromium nickel steel for gas-turbine blades was made, its purpose being to evaluate their effect on the fatigue resistance of this steel under cyclic heat load in an atmosphere containing products of diesel fuel combustion with up to 0.25% sulfur. Two multimetal coating materials, Co-Cr-Al-Y and Ni-Co-Cr-Al-Y as well as a double-layer composite material Co-Cr-Al-Y - ZrO_2<Y_2O_3>(25-70 μm thick layer of tetragonal + monoclinic ZrO_2 stabilized by addition of Y_2O_3) were tested, having been deposited on prismatic wedges of that steel by the electron-beam vaporization and vacuum condensation process. For comparison, bare wedges were also tested in the same manner. Thermal cycling was done in three separate tests, with the maximum temperature 980°C, 1000°C, 1020°C (pressure 500 MPa) respectively. The life wedges was found to be extended by the coatings in tests with lower maximum temperature. Microstructural examination under MIM-7 and "Neophot-2" optical microscopes, x-ray spectral phase analysis in a "Cameca" microanalyzer, and microhardness measurements with a PMT-3 tester under a 50 g load have revealed that the ceramic layer provides high erosion resistance only, while the metal layer provides the fatigue resistance and is where cracks originate at high temperature. References 11: 6 Russian, 5 Western.

2415/9835

UDC 669.187.526:621.793:669.14.018.85

Physicomechanical Properties and Heat Resistance of Fe-Cr-Ni and Fe-Ni-Cr-Al-Y Vacuum Condensates

18420196a Kiev PROBLEMY SPETSIALNOY ELEKTROMETALLURGII in Russian No 4, Oct-Dec 87 (manuscript received 21 Nov 86) pp 42-47

[Article by I. S. Malashenko, N. P. Vashchilo, K. Yu. Yakovchuk, G. F. Badilenko, Ye. S. Bezolyuk and V. G. Vasilyev, Electric Welding Institute imeni Ye. O. Paton, UkSSR Academy of Sciences, Kiev]

[Abstract] New data are presented on the physicomechanical properties as well as heat and corrosion resistance of Fe-Cr-Ni and Fe-Ni-Cr-Al-Y condensate coatings. Such coatings were produced in a UE-137 electron-beam apparatus by simultaneous vaporization of pairs of alloys and deposition of each vapor mixture under vacuum on substrates of rectangular plates of low-carbon steel with width-wise ground surfaces. The three pairs of alloys thus simultaneously processed were: 1) Fe-Cr and Ni-Cr, 2) Fe-Ni-Cr and Fe-Ni-Cr-Al, 3) Fe-Cr-Al-Y and Ni-Cr-Al-Y. The coatings were examined metallographically for microstructure and phase composition. They were tested mechanically for yield point and ultimate strength and for percentage elongation at 20°C and 800°C temperatures as functions of the Fe content (0-50%), of the Ni content (0-25%), and of the Al content (0-4%) with 0.15% Y. Their temperature coefficient of linear expansion was measured over the 100-1100°C range, that of Fe-Cr binary condensates being the lowest and that of Fe-Cr-Ni condensates increasing monotonically with increasing Ni content. Heat resistance in air and corrosion resistance in aqueous solution of 75 g/l Na_2SO_4 + 25 g/l NaCl were measured as functions of the Al content, both at a temperature of 900°C. Increasing Al content was found to increase both. Standard methods of isothermal holding and periodic weighing were used for determining the oxidation kinetics at both 900°C and 300°C temperatures. References 9: 4 Russian, 5 Western.

2415/9835

UDC 669.187.526:621.187.1.(539.2+002.612).001.5

Structure and Some Properties of Al_2O_3 Vacuum Condensates Produced by Electron-Beam Evaporation at High Substrate Temperatures

18420196b Kiev PROBLEMY SPETSIALNOY ELEKTROMETALLURGII in Russian No 4, Oct-Dec 87 (manuscript received 9 Dec 86) pp 48-54

[Article by K. G. Khakhanashvili, F. N. Tavadze, O. P. Shalamberidze and E. R. Kuteliya, Georgian Polytechnical Institute imeni V. I. Lenin, Tbilisi]

[Abstract] An experimental study of Al_2O_3 vacuum condensates was made for the purpose of determining the dependence of their bulk and surface structure as well as some mechanical and electrical properties on their thickness and on the substrate temperature. Cylindrical compacts of pure Al_2O_3 powder were vaporized with an electron beam under vacuum, whereupon the vapor was deposited on 0.1 mm thick and 10 mm wide strip of substrate material under vacuum. Condensates of 1-50 μm thickness were thus built up on substrates at temperatures of 750-1600°C. For microstructural examination under a UEMV-100K transmission electron microscope and phase analysis in a DRON-2 x-ray diffractometer with Fe-radiation as well as microhardness measurements, the condensates were divided into 1-5 μm, 5-10 μm, 10-15 μm, and 15-50 μm thick groups. Porosity and adhesive strength, electric strength and electrical resistivity were also measured. These properties were found to also depend on the phase composition and the grain orientation, the electrical strength of thin condensates much more on the phase composition and that of thick condensates much more on the grain orientation. References 12: 10 Russian, 2 Western.

2415/9835

UDC 669.187.526:539.26.217.001.5

Structural Characteristics and Porosity of Cr-Al_2O_3 Vacuum Condensates

18420196c Kiev PROBLEMY SPETSIALNOY ELEKTROMETALLURGII in Russian No 4, Oct-Dec 87 (manuscript received 31 Dec 86) pp 54-56

[Article by G. M. Kochetov, G. I. Batalin and G. G. Didikin, Kiev State University imeni T. G. Shevchenko and Electric Welding Institute imeni Ye. O. Paton, UkSSR Academy of Sciences, Kiev]

[Abstract] An experimental study of thick Cr-Al_2O_3 porous cermet condensates containing 0.5-24.9% Al_2O_3 was made, the purpose being to determine the feasibility of controlling their porosity by high-temperature annealing. Condensates approximately 1 mm thick were produced by electron-beam evaporation of Cr and Al_2O_3 from separate sources about 250 mm apart under vacuum and subsequent condensation of the vapor mixture under vacuum on St3 carbon steel as the substrate material, the latter preheated to 950°C and coated with a 15-20 μm thick ZrO_2 film. They were then annealed at a temperature of 1100°C for 1-3-5-50 h in an argon atmosphere. Phase analysis

was done in a DRON-3.0 x-ray diffractometer with CuK_α-radiation source. Microstructural examination was done by the method of low-angle x-ray scattering in a RKM-1 instrument with FeK_α-radiation source. Porosity was measured by hydrostatic weighing. The results indicate that high-temperature annealing homogenizes the structure and reduces the porosity of such cermet coatings. References 5: all Russian.

2415/9835

UDC 669.187.526:621.785.3.(061+669.14).018.26

Effect of Electron-Beam Heating on Mechanical Properties and Corrosion Resistance of Steel Tape

18420196d Kiev PROBLEMY SPETSIALNOY ELEKTROMETALLURGII in Russian No 4, Oct-Dec 87 (manuscript received 8 Jul 86) pp 56-60

[Article by F. G. Badilenko, A. V. Demchishin and A. Ye. Kushnirenko, Electric Welding Institute imeni Ye. O. Paton, UkSSR Academy of Sciences, Kiev]

[Abstract] Tape of two low-carbon steels, cold-rolled 08 rimmed and hot-rolled 08 aluminum-killed, was studied in an experiment revealing the effect of electron-beam heating. Tape specimens of each steel, 0.4 mm thick with an 80 cm^2 surface area, were heated with a scanning electron beam within 30-45 s to temperatures of 600-1000°C under a very low pressure of residual gases and held at each temperature for 5 min, whereupon they were cooled under vacuum. Subsequent etching with 3% HNO_3 solution in ethyl alcohol revealed their microstructure and the dependence of the ferrite grain dimension across the direction of rolling as well as of the grain form factor on the heating temperature. Specimens for mechanical tests were cut along the direction of rolling and loaded in tension at a deformation rate of 0.1 min^{-1}. The results of these tests indicate that maximum 0.2% yield strength is reached after heating at a temperature lower than the temperature after heating at which maximum percentage elongation is reached, while the ultimate strength decreases slightly and monotonically as the heating temperature is raised. Corrosion specimens with 2 cm^2 active surface area were tested in aqueous 10% H_2SO_4 solution and 10% HaCl solution at a temperature of 20°C, the remainder of their surface being covered with varnish. The corrosion rate in H_2SO_4 solution was found to drop and stabilize within 6-12 min, while remaining highest after specimens of cold-rolled rimmed steel had been heated at 600°C and specimens of hot-rolled killed steel had been heated at 1000°C. The corrosion rate in HaCl solution was found to increase linearly for cold-rolled rimmed steel after heating at successively higher temperatures throughout the entire range, but to peak slightly for hot-rolled killed steel after heating at 800°C and to drop appreciably after heating at successively higher temperatures. The higher corrosion resistance of hot-rolled killed steel in both solutions is attributable to the presence of Al_2O_3. References 7: all Russian.

2415/9835

UDC 621.762.4.043:661.665.3

Kinetics of B_4C Compaction During Hot Pressing

18420191 Kiev POROSHKOVAYA METALLURGIYA in Russian No 11, Nov 87 (manuscript received 25 Oct 85) pp 18-21

[Article by M. S. Kovalchenko, Yu. G. Tkachenko, L. F. Ochkas, D. Z. Yurchenko and V. B. Vinokurov, Institute of Materials Science Problems UkSSR Academy of Sciences]

[Abstract] An experimental study of hot pressing the nonplastic B_4C material was performed for the purpose of determining the kinetics of its compaction in the process. Powder specimens of pure material (77.5% B_{total} + 21.1% C_{total} + 0.35% O_2) and of material containing 3% Fe as activator, with grains smaller than 1 μm and a specific surface area of 4 m^2/g, were hot-pressed under constant pressure into graphite molds which had been preheated to various temperatures above 2000°C. Porosity and relative density (percentage of ideal) were measured after hot pressing at 2050°C, 2100°C, 2150°C under a pressure of 30 MPa and also with the pressure varied over the 10-40 MPa range for a determination of their dependence on the process duration. The porosity was found to decrease from initial 25% to 10% after 7 min and to below 2% after 120 min at 2100°C, while the relative density was found to increase from initial 50% to 98% after 3 min at 2150°C, to 96% after 5 min at 2100°C, and to 91% after 5 min at 2050°C. The temperature range of intense compaction is thus very narrow. The relative density of B_4C compacts was also found to be strongly pressure-dependent. A theoretical evaluation of the data according to the generalized equation of three-dimensional fiscous flow for a porous body indicates that the basic mechanism of compaction, of pure and activated material alike, is climb of dislocation and resulting creep. References 8: 4 Russian, 4 Western.

2415/9835

UDC 621.762.02

Structure and Some Physical Properties of Superconducting Diamond Film

18420189a Kiev SVERKHTVERDYYE MATERIALY in Russian No 6, Nov-Dec 87 (manuscript received 11Feb 87) pp 19-24

[Article by V. D. Andreyev, V. A. Semenovich, Yu. I. Sozin, T. A. Nachalnaya and V. I. Torishniy, Superhard Materials Institute, UkSSR Academy of Sciences, Kiev]

[Abstract] An experimental study of diamond films produced by deposition of carbon condensate on quartz or sapphire substrates in a glow-discharge plasma without simultaneous doping was made for chemical and structural analysis on quartz substrates and for measurement of electrophysical properties on

sapphire substrates. Diffractograms revealed only five diamond lines, no graphite lines, and yielded the lattice dimensions. Impurities and defects of the dislocation kind were detected in electron-paramagnetic-resonance spectra at room temperature, the intensity of lines increasing on account of the Boltzmann effect but no new lines appearing as the temperature was lowered to 77 K. Diffraction and EPR spectral lines of synthetic diamond powder AS2 100/80 served as reference. The electrical resistance was measured by the voltage-current method and the electrical resistivity was found to vary depending on the film thickness over the 0.1-5 ohm·cm range. Its temperature dependence over the 70-520 K range revealed semiconductor characteristics of such films. The type of semiconductor was determined on the basis of thermo-e.m.f. and Hall-effect measurements, revealing a p-type and thus presence of a boron impurity. With respect to electrophysical properties, such diamond films resemble amorphized Se and Ge films deposited from the gaseous phase. References 17: 14 Russian, 3 Western (1 in Russian translation).

2415/9835

UDC 539.89:546.271

Fine Crystalline Structure of NbB_2 and TaB_2 Sintered Under High Pressure

18420189b Kiev SVERKHTVERDYYE MATERIALY in Russian No 6, Nov-Dec 87 (manuscript received 16 Dec 86) pp 34-36

[Article by A. M. Mazurenko, V. S. Urbanovich, A. I. Olekhnovich and A. A. Voytenko, Solid State and Semiconductor Physics Institute, BSSR Academy of Sciences, Minsk]

[Abstract] An experimental study of sintered NbB_2 and TaB_2 was made for the purpose of determining the dependence of their fine crystalline structure on the sintering temperature over the 1600-2400 K range and on the sintering pressure over the 5.5-7.5 GPz range. Specimens of these materials were sintered for 1 min at each temperature-pressure point. Their microhardness was then measured in a PMT-3 tester with a 0.49 N indenter making an impression 6-8 times wider than the grain dimension. Parameters of the fine crystalline structure, including dimensions of the coherent-scattering domains, were measured in a scanning DRON-3 x-ray diffractometer with a graphite monochromator and two Soller aperatures. Broadening of the 001, 002, 100, 200, 201, 112 lines was evaluated by the method of moments, specimens of NbB_2 and TaB_2 annealed at 1100°C for 12 h serving as references. The results indicate that structure-dependent properties are controllable by regulation of the sintering temperature and pressure. The microhardness has been found to first increase and then decrease as the sintering temperature is raised under contant pressure, the maximum microhardness increasing slightly (NbB_2) or appreciably (TaB_2) as the sintering pressure is raised at some lower temperature. References 3: all Russian.

2415/9835

UDC 621.922.024

Role of Bond and Diamond Grains in Operation of Elastic Tool

18420189c Kiev SVERKHTVERDYYE MATERIALY in Russian No 6, Nov-Dec 87 pp 46-49

[Article by G. I. Kovyzhenko, Superhard Materials Institute, UkSSR Academy of Sciences, Kiev]

[Abstract] Band grinding of the hard alloy WCo8 with diamond grains is evaluated on the basis of experimental data. Tests were performed using 5 mm wide and 1920 mm long bands with ASM or AS2 diamond grains of 10/7-80/63 sizes on four different bonds, the relative concentration of grains being 100% and an aqueous 3% solution of calcined salt serving as lubricant-coolant fluid. Grinding was done with the band running at a velocity of 8 m/s or 16 m/s. Both tangential and normal components of theecutting force were measured by the standard method with 2PKB-20-100 strain gauges and a dynamometer, the latter including a low-inertia high-sensitivity octahedral elastic element. The friction coefficient with the bond alone was 0.08-0.12, the ratio of tangential component to normal component of the cutting force becoming higher upon addition of diamond grains. This ratio first increased with increasing grain and then remained constant with the grain size exceeding 63/50. The surface roughness increased appreciably with increasing grain size and changed only slightly with change of the bond grade. Surface examination of the WCo8 work piece revealed some embedment of diamond grains. An analysis of the data and of the abrasion mechanism indicates that diamond grains not larger than 80/63 should be used so as to minimize their transfer from bond to work piece, larger grains being more loosely embedded in the bond. References 5: all Russian.

2415/9835

UDC 539.211:669.6+669.1+669.21

Alloying of Metals by Treatment With Nanosecond Laser Pulses

18420190a Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 87 (manuscript received 30 Apr 87) pp 14-23

[Article by A. M. Markeyev, V. N. Nevolin and V. Yu. Fominskiy, Moscow]

[Abstract] Surface alloying of metals and steels by treatment with nanosecond laser pulses, resulting in formation of new metastable alloys in the surface layer, is evaluated on the basis of experimental studies of five binary systems. These are implantation of Sn film in Mo, Cr and 20Cr13 steel matrices, implantation of Fe film in Cu matrix, and implentation of Au film in Ni matrix. While Sn is thermophysically very different from Mo, Cr, and 20Cr13 steel, Fe is thermophysically similar to Cu and Au is not only thermophysically but also thermodynamically similar to Ni. Laser radiation of λ = 1.06 μm wavelength was used for implantation and the surface layers were then analyzed by the method of Mössbauer electron spectroscopy. The results indicate the feasibility of producing metastable alloys even when the components differ thermophysically and thermodynamically, the mechanism involving vaporization and plasma formation with subsequent diffusive or convective interaction of ionized hot implantant vapor and the matrix surface layer. Irradiation through a transparent coating was found to raise the efficiency of this process. The authors thank Yu. V. Petrikin for assisting with the Mössbauer electron spectroscopy and I. A. Veselovskiy for assisting with the acoustic measurements. References 12: 7 Russian, 5 Western.

2415/9835

UDC 533.915.03:621.378

Dependence of Laser-Generated Surface Plasma on Graphite Target on Angle of Laser Beam Incidence

18420190b Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 87 (manuscript received 28 Nov 86) pp 24-26

[Article by Ye. B. Kulbatskiy and S. V. Selishchev, Moscow]

[Abstract] Action of laser-generated surface plasma on a graphite target, resulting essentially in vaporization of the latter, is evaluated on the basis of experimental data and theoretical calculations. In the experiment radiation from a Nd-laser (λ = 1.06 μm wavelength) impinged on a graphite plate in pulses of 15 J energy and 1 μs duration with a power density of 10^5-10^6 W/cm^2, at various angles of incidence from 0 to 60° through a gaseous medium (He, Ar,Xe) whose pressure was varied over the 1-15 atm range. While the efficiency of such a surface plasma was found to depend on the angle of laser beam incidence, calculations based on the theory of gasdynamic flow confirm that the flow of the gas-vapor mixture transversely to the laser beam and not its flow parallel to the latter essentially determines the size of the plasma layer. References 6: all Russian.

2415/9835

UDC 621.039.553

Effect of Cyclic Heat Load Changes on Impairability of Austenitic Chromium-Manganese Steel for Use in Fusion Reactor

18420190c Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 87 (manuscript received 11 Mar 87) pp 32-35

[Article by I. A. Murtazin, Ye. V. Demina, L. I. Parshukov, Ye. P. Yelsukov and L. V. Ovechkin, Moscow]

[Abstract] Austenitic low-nickel chromium-manganese steel 05Cr12Mn14N14MoAl was tested for thermal fatigue, this steel having been otherwise found to be suitable for the first wall of a tokamak fusion reactor. A series of tests were performed inside a special vacuum discharge chamber with direct heating by an $E \leq 8$ keV electron beam from a flat cathode and with simulation of cyclic heat load changes likely to occur in service. In accordance with INTOR-project data stipulating at least 10^6 heat load cycles over a period of 10 years, the heaviest heat load on that wall would most likely be 1 MW/cm^2 with up to 289 J/cm^2 local spikes of 20 ms duration caused by plasma stripping. Accelerated testing with heat load pulses of 1-8 MW/m^2 intensity and 5 s duration separated by 20 s intervals, with the coolant at room temperature flowing continuously, allowed one to reduce the number of cycles significantly by increasing their severity. Tubular specimens of

this steel with a 40 mm external diameter and a 12.5 mm or 5 mm wall thickness had been produced by hot forging with some of them subsequently machined on a lathe or by grinding and some left in the rough state. Some but not all were then additionally heat-treated at 1100°C for 1 h with subsequent air-cooling. After the test, surface layers of all specimens were examined for phase composition and defectiveness, Mössbauer spectroscopy supplementing x-ray spectral analysis and the x-ray diffraction method. The results reveal that initial surface roughness and residual stresses after hot forging facilitate formation of the α-phase, but not deeper than 20 μm, and lower the thermal-fatigue resistance. They also indicate that this steel can withstand 10,000 cycles with heat load pulses of up to 3 MW/m^2 intensity, even without machining and without additional heat treatment, which makes it suitable for the given application. References 6: 4 Russian, 2 Western.

2415/9835

UDC 669.14.018.29.017:669.788

Acoustic Emission In and Mechanical Characteristics of Steels Under Conditions Typically Affecting First Wall of Fusion Reactor

18420190d Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 87 (manuscript received 20 Jul 86) pp 41-44

[Article by V. A. Goltsov, G. A. Barannikova, N. A. Ishchenko, Yu. G. Prokofyev, P. A. Fefelov, R. V. Kotelva, V. N. Tyurina, A. V. Vetchinov and I. N. Yakhno, Donetsk]

[Abstract] An experimental study of three austenitic steels (12Cr18Ni10Ti, 06Cr17Mn17, 03Cr20Ni45Mo4Nb) was made for the purpose of determining the effect of hydrogen on their mechanical properties and life under cyclic heat load in a fusion reactor as well as under slowly cycled mechanical load revealing buildup of stresses in critical sections. Austenitized specimens were accordingly first tested mechanically in an IMASH 20-75 apparatus under vacuum and under a hydrogen pressure of 0.15 MPa at temperatures covering the 20-800°C range as well as with the temperature cycled between 450°C and 650°C under various mechanical loads below and above the yield strength at 650°C, also with acoustic emission simultaneously measured at 100°C and at 200°C. They were also tested mechanically in a VTN-1 apparatus under vacuum and under a 0.1 MPa pressure of commercially pure or extra-pure hydrogen at temperatures covering the 20-600°C, with the mechanical load slowly cycled at a frequency of 1/3 cps to a constant amplitude of total strain. The results indicate that gaseous hydrogen, commercially pure or extra pure, only slightly lowers static mechanical properties and thermal fatigue of all three steels, but significantly lowers their dynamic mechanical properties during slow load cycling. In the latter case the 06Cr17Mn17 steel was found to be most immune to the detrimental effects of hydrogen at room temperature. Acoustic emission was found to occur at lower strain levels and reach smaller amplitudes in a hydrogen atmosphere than under vacuum. The authors thank I. N. Yakhno for assisting with the experiments. References 7: all Russian.

2415/9835

UDC 535.211

Interaction of Infrared Laser Radiation and Synthetic Diamonds

18420190e Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 5, Sep-Oct 87 (manuscript received 22 Sep 86) pp 146-148

[Article by Zh. Zh. Zheyenbayev, A. A. Sukenbayev and E. S. Chokoyev, Frunze]

[Abstract] An experimental study was made concerning treatment of synthetic diamonds with infrared laser radiation, such radiation not interaction with the diamond crystal lattice but being either absorbed or scattered by defects and impurities. Considering the technological application of this treatment, a monolayer of AS 50 diamond grains between two KBr or CaF_2 single crystals serving as windows was irradiated for measurement of its absorption spectrum covering 2-25 μm wavelengths in the intermediate-infrared region with an IKS-29 spectrophotometer. Its scattering and transmission indicatrices, plotted with an IMO-2 instrument by moving the calorimeter around a circle in the plane 10 cm away from the light spot, were found to have almost equal maximum amplitudes but quite different shapes. The dependence of the transmission coefficient on the laser radiation intensity measured in two ways, by varying the laser power but not the spot diameter and by varying the spot diameter but holding the laser power constant, was found to change proportionally to the laser power and to be independent of the spot diameter. The authors thank G. P. Bogatyreva for supplying specimens of synthetic diamonds and R. A. Andriyevskiy for helpful discussions. References 5: all Russian.

2415/9835

UDC 621.791.92:621.793.04:631.3

Hard-Facing Agricultural Implements by Means of Electron Accelerator

18420188a Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 87 pp 4-6

[Article by L. P. Fominskiy, engineer, and M. V. Levchuk, engineer, Tulachermet Scientific-Industrial Association; A. F. Vaysman, engineer, and S. N. Fadeyev, engineer, All-Union Scientific Research and Planning Institute of the Cement Industry; S. A. Sidorov, engineer, All-Union Scientific Research Institute of Agricultural Machinery-Building Scientific-Industrial Association; G. F. Murov, candidate of technical sciences, Scientific Research Institute of Tractor and Agricultural Machiner-Building Technology; R. A. Salimov, doctor of physico-mathematical sciences, Nuclear Physics Institute, Siberian Department, USSR Academy of Sciences]

[Abstract] Plough blades and cultivator teeth made of St53 steel and 65Mn steel respectively were experimentally hard-faced with various "sormite" powders (Fe + 2.5-5.4% C + 25-58% Cr + 1-7% Ni + 0.4-3.5% Mn, 0-0.4% W + 0-0.3% Mo, 1-10% Si) containing all size fractions. This was done by means of an electron beam from an accelerator, in air without flux and gaseous shield, after preheating at 400-450°C for prevention of microcracks in the surface layer. The deposit thus produced with strong bonding to the body was found to have a finer grain structure and a more uniform depthwise hardness profile than one produced by induction heating. This is almost independent of the powder grain size fraction and ensures a much higher wear resistance. Elimination of flux and shield decreases the cost and increases the productivity of this hard-facing process. Subsequent heat treatment is not recommended, lest the wear resistance deteriorate. References 5: all Russian.

2415/9835

UDC 621.791.14.03

Pressure Welding of Steel to Copper for Producing Special-Shape Bars

18420188b Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 87 pp 7-8

[Article by B. M. Zhukov, candidate of technical sciences, V. I. Zotin, candidate of technical science, M. L. Makhlis, engineer, and V. I. Romanovskiy, engineer]

[Abstract] Pressure welding of steel to copper during simultaneous hot rolling and hot pressing with large plastic deformation is evaluated on the basis of experimental data on cylindrical bimetal ingots cast with cladding of M1 copper on cores of St08 steel for collectors. Specimens weighing 10-20 mg, cut out after forming, were heated in air to temperatures covering the 300-1200 K range for study of the copper oxidation kinetics on the basis of thermogravitometric analysis and study of the microstructure under a scanning electron microscope. The results indicate that the optimum preheat temperature lies within the 1150-1200 K range, above which the oxide film on the copper surface becomes too thick, and that subsequent 80-90% reduction under a pressure of 1000-1200 MPa yields a welded steel-Cu joint without slippage 180-200 MPa strong with a 50-80 μm wide interdiffusion zone. References 4: all Russian.

2415/9835

UDC 621.791.16.03:621.643.669.296

Friction Welding of Tubes Made of Zr + 2.5% Nb Alloy

18420188c Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 87 pp 9-10

[Article by V. N. Tyurin, engineer, I. S. Lupakov, doctor of technical sciences, M. I. Plyshevskiy, candidate of technical sciences, A. N. Sidorov, engineer, L. T. Rudetskaya, engineer, and I. V. Koltsov, engineer]

[Abstract] Friction welding of tubes made of Zr + 2.5% Nb alloy is evaluated on the basis of experimental data on three sizes of such tubes. Welding was done in a GD-88 machine with and without an argon shield. Tubes with 12 mm diameter and 2.75 mm wall thickness were welded together under a pressure of 1.2 MPa for 3-4 s. Tubes with 63 mm diameter and 4 mm wall thickness were welded together under a pressure of 1.0 MPa for 4-5 s. Tubes with 88 mm diameter and 4 mm wall thickness were welded together under a pressure of 0.8 MPa for 4-5 s. The results of microstructural examination, together with hardness and microhardness measurements, indicate work hardening of the seam metal along the center line and an only a very thin, not more than 50 μm thick, layer of tube metal with gaseous inclusions (200-300 μm thick after welding without argon shield) within the heat-affected zone. The results of mechanical tests indicate that such joints are almost as strong

as the base metal, with a tensile strength of 550-580 MPa, an impact strength of at least 5 MJ/m^2, and a 110-160° deflection angle prior to fracture in static bending. After trimming and surface annealing, such joints were tested for corrosion in water with a high oxygen content (20-40 mg/dm^3) at a temperature of 285°C and under a pressure of 6.8 MPa. They survived 5000 h, much longer than without prior surface annealing. References 5: 3 Russian, 2 Western (in Russian translation).

2415/9835

UDC 621.791.72.03:669.189.45

Producing Kovar-To-Glass Seals by Heating With Light From Xenon-Arc Lamps

18420188d Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 87 pp 10-11

[Article by M. I. Oparin, candidate of technical sciences, and V. B. Redchits, engineer]

[Abstract] Hermetic Kovar-to-glass seals were experimentally produced by heating with a light beam from a xenon-arc lamp rather than conventionally in a furnace after vacuum or hydrogen annealing in a graphite crucible, thus avoiding the detrimental effect of graphite dust. Advantages of this method are that commercial lamps of any power rating and coolable ellipsoidal metal reflectors of any size can be used, the process being easily automated. Seals of S-52-I glass and 29NK Kovar, the latter preoxidized in an open muffle furnace, were produced by heating to 1100-1150°C with a 25 V - 60 A lamp for 5-10 s inside a special argon-filled quartz flask. Metallographical examination has yielded results indicating satisfactory performance characteristics of such seals. References 3: all Russian.

2415/9835

UDC 621.791.72

Butt Welding With Light From Xenon-Arc Lamps

18420188e Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 87 pp 11-12

[Article by V. V. Ovchinnikov, engineer, and S. A. Fedorov, candidate of technical sciences, Moscow Znamya Treda Machine Building Plant]

[Abstract] An experimental study of butt welding with a light beam from a 5 kW xenon-arc lamp using an ellipsoidal metal reflector-concentrator 300 mm in diameter was made in order to determine the distribution of light intensity over the lateral surfaces of the joined parts and optimize the process on this basis. Strips of 12Cr18Ni10Ti corrosion-resistant steel were welded along the edges with the lamp operating in the nominal mode, 34-35 V and 140-150 A, the welding rate having been determined empirically for adequate but not excessive depth of fusion. The results reveal that uniform heating is attainable with the joined parts in horizontal position and the joint in a vertical plane, which requires additional concentrators, a seam joining parts in a vertical position being thinner and a joint in a horizontal plane being weaker. Sheets less than 0.15 mm thick should be held in clamps with reflecting internal edges acting as light concentrators. Conical cups with reflecting internal surface on top of a concentrator narrow down the heating zone. Metallographical examination revealed nondefective bellows-flange joints when welding had been done by such heating to temperatures not exceeding 100-120°C. References 3: all Russian.

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UDC 621.791.755:669.3

Plasma Welding of Fillets on Copper Cylinders

18420188f Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 11, Nov 87 pp 14-15

[Article by Z. Kh. Khasanov, candidate of technical sciences, All-Union Scientific Research, Planning-Design and Technological Institute of Electric Welding Equipment]

[Abstract] Plasma welding of bronze flanges to copper cylinders with annular fillets is described, cylindrical current leads of M1 copper 664 mm in diameter and 950-1050 mm long with flanges of 0.7% Cr bronze being used for electric generators in nuclear power plants. Welding is done with a 1.5 kA d.c. plasmatron which has a tungsten electrode 8-10 mm in diameter and a nozzle 9-11 mm in diameter. A power supply with voltage regulation from 180 V no-load to 90 V full-load is required, with appropriate means for igniting and maintaining a 50-70 mm long arc. The plasma generating gas during ignition and buildup of an arc is argon, to which approximately 50% helium is added

for maintenance of a 600-650 A arc at a voltage of 60-62 V. A special fixture includes a manipulator with an arm on a vertical face plate holding the cylinder with flanges and movable from horizontal to 45+5° inclined position, and a guide bar sliding on the cylinder surface attached to a horizontal cantilever beam whch also carries an automatically sliding box with filler wire and can be swung through a 90° angle by rotation of the support column. Welding is done in a single pass at a rate of 6 m/h, with filler wire of CoMn3-1 bronze 2 mm in diameter fed at a rate of 80-100 m/h and gas fed at a rate of 450-550 1/h. References 2: both Russian.

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9 April 1988